

**Remarks/Arguments:**

No claim amendments are made with this Response, so claims 1-52 remain as the pending claims. Claim 14 has been withdrawn from consideration.

For the reasons set forth below, the applicants respectfully request reconsideration of the rejections and early notification of the allowance of the pending claims. To expedite prosecution, the applicants' representatives request a telephonic interview with the Examiner, if needed, and will contact the Examiner for scheduling.

**I. The Office Action**

The Office Action maintains the rejection of claims 1-9 and 12 under 35 U.S.C. §102(b) as anticipated by Hausler (U.S. Patent No. 3,881,957). The Office Action also maintains the rejection claims 1-13 and 15-52 under 35 U.S.C. §103(a) as unpatentable over Wilkinson et al. (EP 0 736 921) in view of Hausler. The Examiner submits that a skilled artisan would have found it obvious to modify Wilkinson et al. to employ a catalyst on a non-conductive support as taught by Hausler thereby increasing the electrical conductivity of the electrodes.

**II. Lack of Anticipation**

The applicants submit that Hausler does not teach each and every feature of claim 1. The structure of an electrically non-conducting support for first catalyst is not suggested or disclosed by Hausler.

In particular, the applicants respectfully disagree with the Office Action characterization of the pyrolyzed refractory oxide in Hausler. The Office Action states: "the examiner asserts that Hausler does not form a semi-conducting *support* - it is the *electrode material* that is disclosed as being semi conducting," (emphasis in the original). Citing col. 5, line 62 et. seq. The applicants contend that this statement represents a misunderstanding of Hausler. Through the remarks below, the applicants will demonstrate that (A) Hausler teaches transformation of a non-conducting refractory metal oxide, such as alumina, into an electrically conducting, pyrolyzed refractory oxide material, and (B) that with this correct understanding of the teachings of Hausler, Hausler does not teach the feature of claim 1 which requires an electrically non-conducting support for a first catalyst.

**A. Hausler is directed to a novel semi-conducting coated refractory oxide.**

Hausler is directed to a novel semi-conducting refractory metal oxide having a carbonaceous pyropolymer monolayer on the surface of the refractory metal oxide. Col. 3, lines 4-11. This novel semi-conducting material is used to support a catalytic metal to form an electrode of an electrochemical cell. Col. 5, lines 61-66 and col. 10, lines 26-35. Hausler teaches that treatment of a refractory oxide with a pyropolymer imparts electrical conductivity to the refractory metal oxide, which electrical conductivity increases in three stages. Col. 7, lines 1-3.

During stage one, the surface of the refractory oxide reacts with the pyrolyzable substance to form an acceptor-donor charge transfer complex. Col. 7, lines 3-5. Stage two occurs when the pyrolyzed refractory oxide becomes semi conducting at room temperature. Hausler teaches that conductivity slows during this stage when compared to stage one, but still increases by two to three orders of magnitude. Col. 7, lines 29-35. During stage three, the pyropolymer molecules increase in size, its molecular orbitals overlap, and the intermolecular potential barriers are reduced, resulting in a further increase in conductivity of the coated refractory oxide. Col. 8, lines 13-19.

The pyropolymer monolayer on the surface of the alumina oxide is not a separate and distinct layer applied to the refractory metal oxide. The pyropolymer layer is formed through chemical and electrical alteration of the refractory metal oxide at the molecular level. Col. 6, lines 37-43. This alteration changes the properties of the refractory metal oxide. For example, when the refractory oxide is alumina, it changes from electrically non-conducting to electrically semi-conducting. Hausler describes how the pyrolyzable substance reacts with the alumina surface at the active sites of alumina. Col. 6, lines 65-67. This reaction can occur chemically, for example by the reaction of a refractory oxide with benzene (see col. 9, lines 7-9) and can be promoted catalytically (see col. 6, lines 43-48). Thus, after pyrolyzation, the alumina no longer maintains its normal properties; it is now semi-conducting.

Hausler teaches using this novel semi-conducting pyrolyzed refractory oxide in the manufacture of an electrode. Specifically, Hausler discloses that a gas diffusion electrode was manufactured by combining the "semi-conducting alumina" with a Teflon powder containing Pt compacted on a platinum wire screen to form an electrode composite. Col. 10, lines 26-35.

**B. Contrary to the Office Action, Hausler does teach forming a semi-conducting support for a catalyst.**

The Examiner submits that Hausler does not form a semi-conducting support, but instead submits that Hausler teaches that it is the electrode material that is semi-conducting. Therefore, the Examiner submits that because Hausler uses alumina as the refractory metal oxide, and because alumina is electrically non-conducting, it anticipates the electrically non-conducting support feature of claim 1.

The applicants submit that the Examiner's interpretation of Hausler is in error. There is no disclosure in Hausler that teaches a non-conducting support for a first catalyst. As discussed above, the novelty of Hausler is in the electrically semi-conducting alumina, which Hausler discloses as a support for Pt metal. See col. 10, lines 28 and 29. Provided below are specific exemplary passages of Hausler clearly showing that Hausler discloses that the novel pyrolyzed refractory metal oxide, i.e. alumina, is electrically semi-conducting. These passages directly rebut the Examiner's assertion that "Hausler does not form a semi-conducting support."

Col. 10, lines 27 and 28	"semi-conducting alumina"
Col. 7, line 1	"the electrical conductivity of the refractory oxide"
Col. 8, lines 23 and 24	"rise in conductivity of the coated refractory oxide"

The applicants submit that the Examiner's read of Hausler is contrary to its plain and clear meaning. Reconsideration and withdrawal of the rejection under Section 102(b) is respectfully requested.

**III. Non-obviousness**

The applicants submit the pending claims are patentable over Wilkinson in view of Hausler. In this section of the Response, the applicants submit that the pending claims are unobvious over the cited references because the combination of references still fails to teach each and every feature of the present invention. Then, the applicants rebut specific statements made by the Examiner in the Final Office Action to clarify the prosecution record of the claimed invention.

**A. Hausler and Wilkinson fail to teach all the claimed features.**

In the April 28, 2005 Office Action, the Examiner acknowledged that Wilkinson fails to disclose the claimed feature of "a porous substrate having a catalyst supported on an electrically non-conductive support." As argued above, Hausler also fails to disclose this claimed feature. Therefore, the combination of Wilkinson and Hausler fails to teach or suggest each and every limitation of the claimed invention. Reconsideration of the rejection is respectfully submitted.

**B. The applicants rebut specific comments made in the Final Office Action.**

The Examiner states that the previous technical reasons regarding the combination of the prior art references is merely attorney argument, unsupported by evidence.

The applicants provide further evidence to support that the technical considerations for high temperature fuel cells (Hausler) and low temperature fuel cells (Wilkinson) are completely different, thus negating any motivation to combine these references. A fuel cell with a solid electrolyte, operating at 800 - 1200°C (as referenced in col. 1, line 61 of Hausler) is a solid oxide fuel cell. A fuel cell with a solid polymer electrolyte, operating at 70 - 120°C (as described in Wilkinson et al.) is a proton exchange membrane fuel cell. Enclosed are definitions for an oxide fuel cell and a proton exchange membrane fuel cell from the Fuel Cell Glossary published by the U.S. Fuel Cell Council. These definitions are evidence that the fuel cells of Hausler and Wilkinson are technically different and would be understood by one having ordinary skill in the art to have different electrolytes (a ceramic versus a hydrated polymer) and different cell reactions. As a result, one of ordinary skill in the art would know that these two different fuel cells also have different catalytic requirements and different tolerances of poisonous species. Thus, the applicants' arguments, supported by evidence, demonstrate that there is no motivation for one of ordinary skill in the art to look to the fuel cell of Hausler in combination with the fuel cell of Wilkinson because these fuel cells are technically different. Reconsideration of the rejection is respectfully requested.

The Examiner assumes that the difference in temperature between the fuels cells of the prior art is merely "indicative of technical progression in the art towards lower temperature (and hence more thermally efficient) fuel cells." The applicants' challenge this statement and request that the Examiner provide documentary evidence to support this conclusion. MPEP

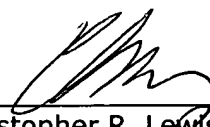
2144.03. Moreover, the applicants' challenge the Examiner on the technical accuracy of this statement. Fuel cells are heat producers, so operating at lower temperatures may not actually be indicative of fuel cell performance.

Finally and to clarify the record, the applicants' previous statement that "one of ordinary skill in the art would not expect the inclusion of a non-conductive support to increase conductivity" is not inconsistent with applicants' characterization of Hausler. This statement refers to the unexpected results of the applicants' own invention, that is, the applicants' claimed invention of a non-conducting support for a catalyst in an electrode increases the catalyst electrode conductivity. It is unclear to the applicants how this statement is contrary to that which was argued regarding Hausler, where (as argued above) Hausler teaches an electrically conducting support.

#### IV. Conclusion

For the reasons set forth above, one of ordinary skill in the art would understand that Hausler teaches transforming a non-conductive refractory oxide, e.g., alumina, into a semi-conducting support through chemical reaction with a pyropolymer. Because neither Hausler nor Wilkinson disclose a non-conducting support for a first catalyst, the pending claims are not taught or suggested by the cited references alone or in combination. Reconsideration of the rejections is respectfully requested.

Respectfully submitted,



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Enclosure: Pgs. 28, 31 and 32 of the "Fuel Cell Glossary" (4 pgs.)

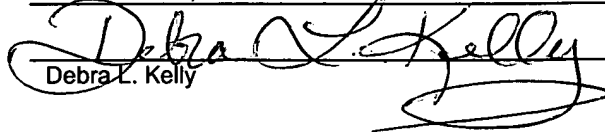
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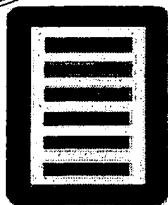
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US Fuel Cell Council

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# FUEL CELL GLOSSARY

## Second Edition – May 2000

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## Fuel Cell Glossary

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**PRESSURE (PRESSURIZED) VESSEL.** See **VESSEL, PRESSURE.**

**PROGRAMMABLE CONTROLLER.**

A digitally operating electronic system designed for use in an environment, which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control, through digital or analog inputs and outputs, various types of processes or machines.

**PROPER VENTILATION.** See **VENTILATION, PROPER.**

**PROTON EXCHANGE MEMBRANE (PEM).**

The separating layer in a PEM fuel cell that acts as an electrolyte (which is proton conducting) as well as a barrier film separating the hydrogen-rich feed in the cathode compartment of the cell from the oxygen-rich anode side.

**PROTON EXCHANGE MEMBRANE FUEL CELL (PEMFC or PEFC).**

A type of acid based fuel cell in which the exchange of protons ( $H^+$ ) from the anode to the cathode is achieved by a solid, aqueous membrane impregnated with an appropriate acid. The electrolyte is called a proton-exchange membrane (PEM). The fuel cells typically run at low temperatures ( $<100^\circ C$ ) and pressures ( $< 5 \text{ atm}$ ).

Anode reaction:  $H_2 \rightarrow 2H^+ + 2e^-$

Cathode reaction:  $\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O$

Overall reaction:  $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

**PURGE.**

To free a gas conduit of air, gas or a mixture of air and gas.

**RATED POWER.**

The value stated on the generator nameplate. It is the power available at the output terminals of a component or piece of equipment that is operated in compliance with the manufacturer's performance specifications.

**REACTION RATE.**

A measure of the speed of a chemical reaction. The reaction rate depends on the rate constant, the number of reactants involved in the reaction and their concentration. For reactions that are otherwise slow, a catalyst is employed to increase the reaction rate.

**REFORMER.**

A vessel within which fuel and other gaseous recycle stream(s) (if present) are reacted with water vapor and heat, usually in the presence of a catalyst, to produce hydrogen rich gas for use within the fuel cell power plant.

**REFORMATE GAS.**

The fluid which exits the fuel reformer and acts as feed to the fuel cell stack.





## Fuel Cell Glossary

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### **SERIES CONNECTION.**

The connection of electrical cells in a positive to negative pattern such that individual cell voltages are additive.

### **SERVICE FACTOR.**

A multiplier that, when applied to the rated power, indicates a permissible power loading that may be carried under the conditions specified for service factor.

### **SHIELD, RADIATION.**

A separate panel or panels interposed between surfaces and jackets to reduce heat losses through radiation.

### **SHIFT CONVERSION.**

The reaction of CO with water to generate carbon dioxide and hydrogen. This process is performed immediately after the reformer and before the preferential oxidizer to reduce CO from approximately 10% down to 0.5% to 0.1% usually through a water gas shift reaction.

### **SHUT-DOWN.**

When a system is not supplying or receiving power (the process of decreasing the power to zero).

### **SHUTDOWN, SAFETY.**

The action of shutting off all fuel and ignition energy to the fuel utilization equipment by means of a safety control or controls such that restart cannot be accomplished without manual reset.

### **SHUTOFF DEVICE, SAFETY.**

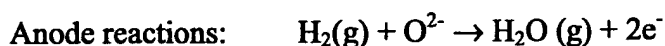
A device that will shut off the fuel supply to the controlled burner in the event the source of ignition fails. This device may interrupt the flow of fuel to the main burner only, or to the pilot and main burner under its supervision.

### **SINGLE CELL TEST.**

A test of the fuel cell performance based on one unit cell. The test is typically a laboratory-scale test in which several variables can be adjusted in order to obtain data over a wide range of conditions, such as temperature, current density, fuel and oxidant flow rates, etc. The outcome of a single cell test may be a polarization curve, a voltage stability plot, or other data related to fuel cell performance.

### **SOLID OXIDE FUEL CELL (SOFC).**

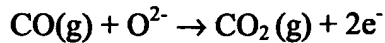
A type of fuel cell in which the electrolyte is a solid, nonporous metal oxide, typically  $\text{ZrO}_2$  doped with  $\text{Y}_2\text{O}_3$ , and  $\text{O}^{2-}$  is transported from the cathode to the anode. Any carbon monoxide (CO) in the reformat gas is oxidized to carbon dioxide ( $\text{CO}_2$ ) at the anode. Temperatures of operation are typically 800 – 1000°C.





## Fuel Cell Glossary

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Cathode reaction:  $\text{O}_2 + 4\text{e}^- \rightarrow 2\text{O}^{2-}$

Overall reaction:  $\text{O}_2 + \text{H}_2 + \text{CO} \rightarrow \text{H}_2\text{O} + \text{CO}_2$

### SOUND LEVEL.

The sound pressure level (in decibels) at a point in a sound field, averaged over the audible frequency range and over a time interval, with a frequency weighting and time interval specified by the American National Standard Association.

### SPECIFIC GRAVITY.

The ratio of the weight or mass of a given volume of a substance to that of an equal volume of another substance (air for gases, water for liquids and solids) used as a standard, both measured under the same conditions.

### SPECIFIC POWER. (kW/kg).

A measure of the energy generating or storage potential of a system per unit of weight.

### STACK END FRAME.

A frame used to compress the individual cells together to maintain electrical conductivity. Also may be known as an end plate or compression end plate.

### STACK LIFE.

The cumulative period of time that a fuel cell stack may operate before its output deteriorates below a useful minimum value

### STACK TEST.

Experiment where an electrical load is applied to a stack of fuel cells to determine its ability to perform. Normally, the output seeks two pieces of information. First is a current output at a specific cell voltage point. Second is a continuous voltage vs. current curve (polarization curve.)

### STACKING.

The process of placing individual fuel cells adjacent to one another to form a fuel cell stack. Normally, the stack is connected in a series.

### STANDARD ATMOSPHERE.

A standard unit of atmospheric pressure, defined as that pressure exerted by a 760-millimeter column of mercury at standard gravity (980.665 centimeters per second per second) at temperature 0 degrees C.

### STANDARD CONDITIONS.

The test or operating conditions that have been predetermined to be the basis of the test in order to have reproducible, comparable sets of test data. Typical conditions that are standardized are fuel and oxidant flow rates and ratios, temperature, pressure, electrode area, catalyst loading, etc.